United States Environmental Protection Agency	Office of Research and Development

National Exposure Research Laboratory
Research Abstract

Government Performance Results Act (GPRA) Goal 1
Annual Performance Measure #317

Significant Research Findings:

An initial linkage of the CMAQ modeling system at neighborhood scales with a human exposure model

Scientific Problem and Policy Issues

Historically, Gaussian plume models have been used to compute ambient concentrations of air toxic pollutants for input to human exposure models. As summarized by EPA's Science Advisory Board in a review of the National Air Toxics Assessment (NATA) program (www.epa.gov/ttn/atw/sab/sabrev.html), most Gaussian-based modeling systems do not account for complex chemical reactions and do not properly address background concentrations. This research is seeking to provide air toxic concentrations from an advanced photochemical grid model to a human exposure model. The introduction of this new capability will benefit the NATA program and other human exposure modeling activities within EPA. This research specifically addresses the following scientific question: Can a grid-based chemical transport model successfully replace and/or augment traditional Gaussian plume modeling approaches for providing annual ambient concentration estimates of air toxics for human exposure assessments in urban settings?

Research Approach

To link the CMAQ modeling system to a human exposure model, the following approach was taken: (1) An air toxics version of the CMAQ modeling system was extended to a modeling domain centered over Philadelphia at 12-km and 4-km grid meshes. Model simulations were performed for the year 2001 for the two grid meshes. (2) The modeling results were compared against limited observational data collected at Camden, New Jersey under the Urban Air Toxics Monitoring Program (www.epa.gov/ttn/amtic/files/ambient/airtox/main-2a.pdf . (3) The modeling results were reformatted into the 3-hour annual averages needed for input to EPA/OAQPS's Hazardous Air Pollutant Exposure Model (HAPEM5). The gridded results were mapped onto the centroids of the census tracts, which are the geographical entities used by HAPEM for its exposure calculations. (4) The practicality of using CMAQ for estimating air toxics for human exposure assessments was assessed by examining the computational requirements needed for this exercise. The findings from this demonstration were communicated to OAQPS and EPA Regional scientists in the form of a briefing, which is available for viewing at www.epa.gov/asmdner/pdf/APM317.pdf.

Results and Impact

This work has demonstrated that a numerical chemical transport model can be a useful tool to simulate the air toxic concentration fields needed to drive HAPEM5, a human exposure model. A comparison of the modeled concentrations with a limited set of observations suggests that the CMAQ model was able to reproduce the temporal features embedded in the data. For this pilot study, air toxic concentrations generated by the CMAQ modeling system for a 4-km grid mesh overlaying Philadelphia were successfully formatted for direct use in the Hazardous Air Pollutant Exposure Model (HAPEM5). Based on these results, CMAQ is being considered for application for the National Air Toxics Assessment (NATA) program.

Research Collaboration and Research Products

Assistance for the CMAQ simulations was provided under Contract #68-W-01-032 with the Computer Sciences Corporation. The research effort also benefitted from interactions with EPA/OAQPS, EPA/Region 3, and the State of Delaware. Ted Palma (EPA/OAQPS) provided the HAPEM5 results based on reformatted CMAQ output files. EPA/Region 3 is providing ISCST simulations for Philadelphia to examine the integration of ISCST with CMAQ, which may ultimately lead to an augmentation of a CMAQ-based approach. Dr. Raj Majeed (State of Delaware, Division of Air Quality) is using the results from this effort to examine the application of CMAQ with an 1-km grid cell size mesh covering Delaware. These collaborations have been formalized via a memorandum of collaboration that was signed by EPA/ORD, EPA/Region 3, and the State of Delaware in April 2004.

Recent publications associated with this research task include the following:

Ching, J., T. Pierce, T. Palma, W. Hutzell, R. Tang, A. Cimorelli, and J. Herwehe, "Linking air toxic concentrations from CMAQ to the HAPEM5 exposure model at neighborhood scales for the Philadelphia area." Presented at the American Meteorological Society's 16th Conference on Biometeorology and Aerobiology, Vancouver, Canada, August, 2004.

Ching, J., S. Dupont, R. Gilliam, S. Burian, and R. Tang "Neighborhood scale air quality modeling in Houston using urban canopy parameters in MM5 and CMAQ with improved characterization of mesoscale lake-land breeze circulation" Presented at the American Meteorological Society's 5th Conference on the Urban Environment, Vancouver, Canada, August, 2004.

Dupont, S., T. Otte, and J. Ching, "Simulation of meteorological fields within an above urban and rural canopies with a mesoscale model (MM5)" *Boundary-Layer Meteorology*, **113**: 111-158, 2004.

Future Research

The next phase of this research effort will focus on extending the CMAQ modeling system for simulating air toxics with finer grid cell sizes (~1 km). Applications are planned for Houston, which is an excellent urban test bed for further development because it has a detailed building morphology database to test the urban parameterizations for meteorological modeling and it has detailed air toxic concentration data (from field studies such as the TexAQS 2000 air quality study) that can be used for extensive model evaluation. The results of this study will be useful for human exposure assessments with NERL's more comprehensive exposure model, SHEDS.

Contacts for Additional Information

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